PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.:—F 23 d 17/00

COMPLETE SPECIFICATION

Improvements in or relating to Burners for Pulverised Coal or like Solid Fuel or for Liquid or Gaseous Fuel

I, JÁNOS MIKLÓS BEÉR, of the Department of Fuel Technology, University of Sheffield, St. George's Square, Sheffield, 1, a Hungarian citizen, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to burners for pulverised coal or like solid fuel or for liquid or gaseous fuel and has for its object the provision of a burner for high intensity combustion or reaction of such fuels with gaseous reactants, such as air, oxygen or oxygen-enriched air, or carbon dioxide.

The invention makes use of the principle that high volumetric heat release rates can be obtained under turbulent conditions by matching the concentrations and directions of flow of fuel and gaseous reactant in such a way that regions of high fuel concentration overlap regions of large shear stresses in the flow of gaseous reactant.

According to the present invention, a burner for pulverised coal or like solid fuel or for liquid or gaseous fuel comprises a plurality of concentric annular divergent nozzles, with the inner end of each nozzle aligned substantially with the outer end of the adjacent inner nozzles, and adapted to be supplied with a gaseous reactant and fuel in such a manner that the bulk of the fuel is directed into close proximity to the walls of the nozzles whereby considerable turbulence will be created by overlap with the regions of high shear stresses in the gaseous reactant resulting from the gradients of velocity caused by flow of the gaseous reactant close to the walls.

Means are preferably provided for rotating the gaseous reactant, and/or gaseous fuel flowing into the nozzles, so that a forced vortex type flow is developed in the nozzles, the peaks of both axial and tangential flow velocity being close to the walls and, therefore, the pressure — as well as the turbulence — being greatest close to the walls. Thus, with gaseous fuel the nozzles may be mounted at one end of the array of concentric pipes from which reactant and/or fuel supply tubes extend tangentially; alternatively, with solid or liquid fuel, the concentric pipes carrying the nozzles may be provided with reactant and/or fuel supply tubes extending parallel to the axis of the burner, and baffles provided in the pipes for causing rotation of the reactant and/or fuel flowing between themselves and the nozzles.

Each divergent nozzle may be preceded by a convergent portion, with the inner end of the divergent portion aligned substantially with the outer end of the divergent portion of the adjacent inner nozzle. Thus each nozzle may be formed by a ring having a venturi-shaped axial section, i.e., rounding rapidly from the inlet end to a minimum inside diameter and then diverging gradually to the outlet end, the outside of the ring being cylindrical and secured and sealed to the inside of one of the array of concentric pipes, the adjacent pipe end preferably being flared internally to continue the divergence of the nozzle.

The invention finds particular advantage in the provision of a large burner without loss of combustion intensity towards the periphery of the burner. Thus, while two concentric nozzles may suffice, one or more further annular divergent nozzles are preferably provided, with the inner end of each

divergent nozzle aligned substantially with the outer end of the preceding nozzle.

One large divergence is formed by the array of divergent nozzles and owing to the radial pressure gradient in the large divergence, there is a strong reverse flow on the burner axis. This flow consists mainly of hot combustion products and plays an important role in flame stabilisation, which in turn enables large turn-down ratios to be obtained, while maintaining the original conditions of high combustion intensity. Complete combustion with very little excess gaseous reactant can be obtained for all rates of combustion.

The concentric pipes may be axially adjustable relative to each other, to adjust the relative positions of the nozzles for fine "tuning" of the burner to suit any operating conditions; thus each pipe may extend rigidly from an annular wall at the end remote from the nozzles, the annular wall being adapted to screw or slide in sealing engagement on the outside of the preceding inner pipe. However, more usually a burner will be required for substantially closely maintained operating conditions, so that each annular wall may be rigidly secured (e.g., by welding) on the preceding inner pipe. Bracing stays may be provided between adjacent pipes intermediate the nozzles and the supply tubes; thus baffles as described above may serve as bracing stays or as additional bracing stays.

A fuel supply system for a liquid or pulverised fuel burner may be a single spray jet mounted centrally of the innermost nozzle, with a spray angle close to the angle of divergence of the nozzle, and the or each or any one additional nozzle may be provided with a ring of similar spray jets or a ring main with an annular spray jet or a succession of fan jets directed close to the wall of the nozzle. In a large burner (say six or more nozzles), all the nozzles may be provided with air supply tubes, while only the central nozzle and one or two additional nozzles have fuel jets.

The fuel supply system for a gaseous fuel burner may have alternate nozzles provided with gas supply tubes, the other nozzles being provided with air or other gaseous reactant supply tubes.

The two systems may be provided in one burner, for optional fuel supplies or, if desirable, operation with mixed fuels, e.g., oil and gas or pulverised fuel and gas.

The outermost nozzle or its mounting pipe may be provided with an annular flange, by means of which the burner may be secured in an opening in a furnace wall. The supply tubes may be provided with end fittings enabling flexible tubes from suitable sources (e.g., mains gas, oil tank, and compressed air line) to be connected and disconnected as required.

Because of the continuous flow of air or other gaseous reactant over the surfaces of the nozzles, keeping them cool despite considerable heat generated by the burner, the nozzles can be formed of mild steel, as can also all the other parts of the burner, thus avoiding any need for materials that are expensive or difficult to work.

One embodiment of the invention, a burner with both oil or pulverised fuel and gaseous fuel systems, will now be described, by way of example only, with reference to the accompanying drawings, in which

Figure 1 is a part-sectional elevation of the burner;

Figure 2 is a section taken on the line 2—2 of Figure 1; and

Figure 3 is an elevation of the right-hand end only of Figure 1.

The burner has six concentric divergent nozzles 1A . . . 1F, formed by rings 2A . . . 2F each of venturi-shaped axial section and mounted in pipes 3A . . . 3F, with the adjacent pipe ends 4A . . . 4F flared internally to continue the divergence of the nozzles, and with the inner end of the divergent portion of each nozzle aligned with the outer end of the preceding inner nozzle. The pipe 3F has an annular end wall 5F welded to the pipe 3E, which in turn has an annular end wall 5E welded to the pipe 3D, and so on, down to the pipe 3A, which has an annular end wall 5A welded to a tube 6 for supplying oil or pulverised fuel to a jet 7 in the nozzle 1A, a tube 6X also passing through the annular end wall 5D for supplying oil or pulverised fuel to a ring of jets 7X between the nozzle end of the pipe 3C and an additional concentric pipe 8.

Tubes 9A . . . 9F extend tangentially from the closed ends of the pipes 3A . . . 3F, three in one direction and three in the opposite direction in alteration (in this case upwards and downwards), as is convenient for connecting one set of three (say 9A, 9C, 9E) to a supply of gaseous fuel and the other set of three to a compressed air line, so that alternate nozzles are supplied with gas (1A, 1C, 1E) and air (1B, 1D, 1F). However, when burning oil or pulverised fuel supplied by the tubes 6, 6X to the jets 7, 7X, all six tubes are connected to a compressed air line.

By matching the rates of flow of fuel and air, regions of high fuel concentration overlap regions of large shear stresses in the flow of air in close proximity to the walls of the nozzles, considerable turbulence being created. Because of the tangential entry of the gas or air into the pipes 3A . . . 3F, a forced vortex type flow is developed in the nozzles the peaks of both axial and tangential flow velocity being close to the walls and, therefore, the pressure — as well as the turbulence — being greatest close to the walls. Owing to the radial pressure gradient in the large diver-

gence formed by the array of nozzles 1A . . . 1F, there is a strong reverse flow on the burner axis, which flow consists mainly of hot combustion products and plays an important role in flame stabilisation, which in turn enables large turn-down ratios to be obtained while maintaining the original conditions of high combustion intensity. Complete combustion with very little excess air can be obtained for all rates of combustion.

WHAT I CLAIM IS:—

1. A burner for pulverised coal or like solid fuel or for liquid or gaseous fuel comprising a plurality of concentric annular divergent nozzles, with the inner end of each nozzle aligned substantially with the outer end of the adjacent inner nozzle, and adapted to be supplied with a gaseous reactant and fuel in such a manner that the bulk of the fuel is directed into close proximity to the walls of the nozzles.

2. A burner as in Claim 1, wherein means is provided for rotating the gaseous reactant, and/or gaseous fuel flowing into the nozzles, so that a forced vortex type flow is developed in the nozzles.

3. A burner as in Claim 2, wherein, with gaseous fuel, the nozzles are mounted at one end of an array of concentric pipes from which reactant and/or fuel supply tubes extend tangentially.

4. A burner as in Claim 2, wherein, with solid fuel or liquid fuel, the nozzles are mounted at one end of an array of concentric pipes which are provided with reactant and/or fuel supply tubes extending parallel to the axis of the burner, and baffles are provided in the pipes for causing rotation of the reactant and/or fuel flowing between themselves and the nozzles.

5. A burner and in any of Claims 1 to 4, wherein each divergent nozzle is preceded by a convergent portion, with the inner end of the divergent portion aligned substantially with the outer end of the divergent portion of the adjacent inner nozzle.

6. A burner as in Claim 5, in combination with Claim 3 or Claim 4, wherein each nozzle is formed by a ring having a venturi-shaped axial section, the outside of the ring being cylindrical and secured and sealed to the inside of one of the array of concentric pipes.

7. A burner as in Claim 6, wherein the adjacent pipe end is flared internally to continue the divergence of the nozzle.

8. A burner as in any of Claims 3, 4, 6 and 7, wherein the concentric pipes are axially adjustable relative to each other, to adjust the relative positions of the nozzles for fine "tuning" of the burner to suit any operating conditions.

9. A burner as in Claim 8, wherein each pipe extends rigidly from an annular wall at the end remote from the nozzles, the annular wall being adapted to screw or slide in sealing engagement on the outside of the preceding inner pipe.

10. A burner as in any of Claims 3, 4, 6 and 7, wherein each concentric pipe extends rigidly from an annular wall at the end remote from the nozzles, the annular wall being rigidly secured on the preceding inner pipe.

11. A burner as in any of Claims 8 to 10, wherein, bracing stays are provided between adjacent pipes intermediate the nozzles and the supply tubes.

12. A burner for liquid or pulverised fuel as in any of Claims 1 to 11, wherein a fuel supply system is a single spray jet mounted centrally of the innermost nozzle, with a spray angle close to the angle of divergence of the nozzle, and the or each or any one additional nozzle is provided with a ring of similar spray jets or a ring main with an annular spray jet or a succession of fan jets directed close to the wall of the nozzle.

13. A burner for gaseous fuel as in any of Claims 1 to 11, wherein alternate nozzles are provided with gas supply tubes, and the other nozzles are provided with air or other gaseous reactant supply tubes.

14. A burner for use with optional fuel supplies or operation with mixed fuels, the burner being provided with the fuel supply systems as in Claim 12 and Claim 13.

15. A burner as in any of the preceding Claims, wherein the outermost nozzle or its mounting pipe is provided with an annular flange, by means of which the burner can be secured in an opening in a furnace wall.

16. A burner as in any of the preceding Claims, wherein the supply tubes are provided with end fittings enabling flexible tubes from suitable sources to be connected and disconnected as required.

17. A burner as in any of the preceding Claims, wherein the nozzles are formed of mild steel.

18. A burner for pulverised coal or like solid fuel or for liquid or gaseous fuel substantially as hereinbefore described with reference to the accompanying drawings.

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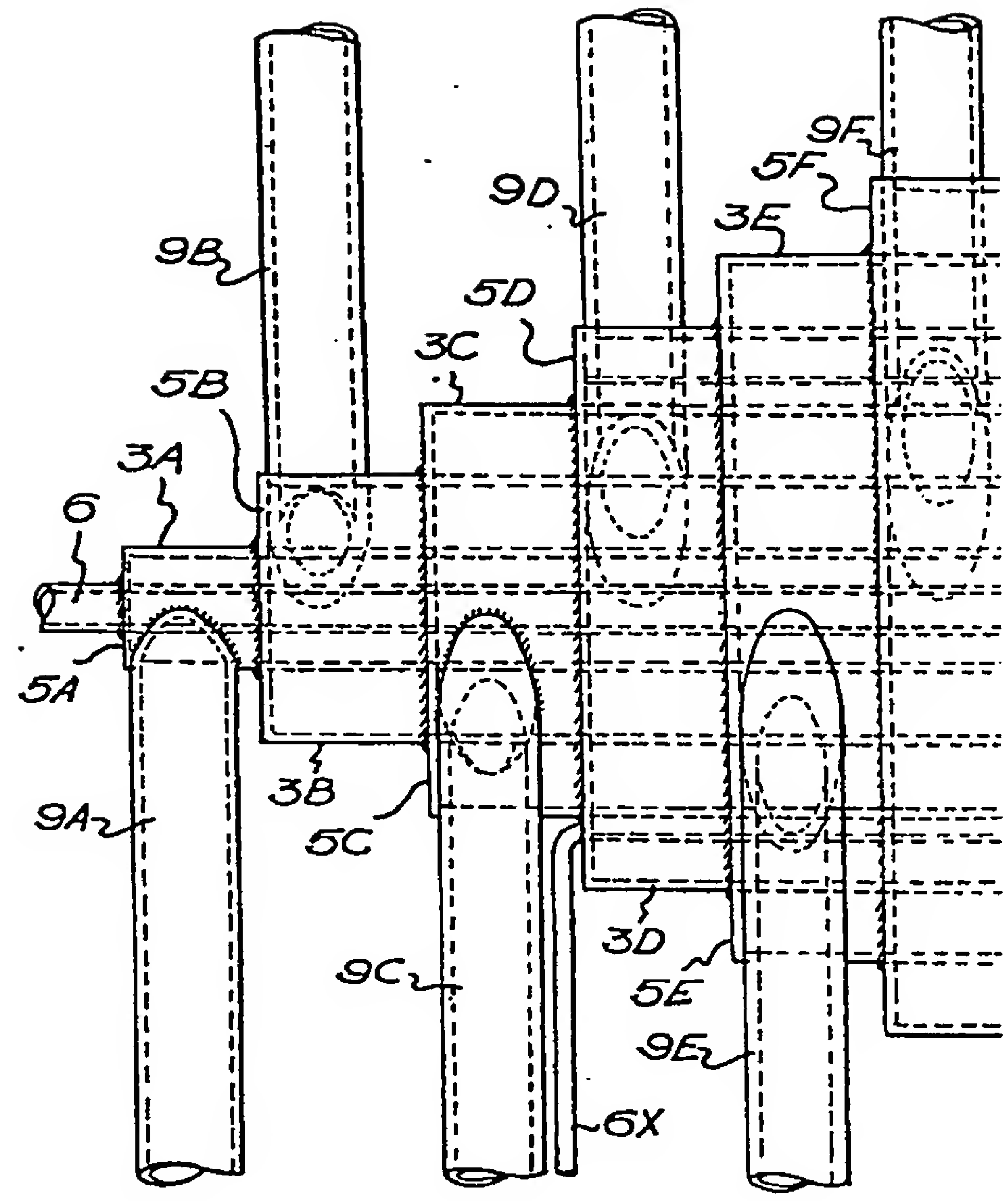
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9D
9F
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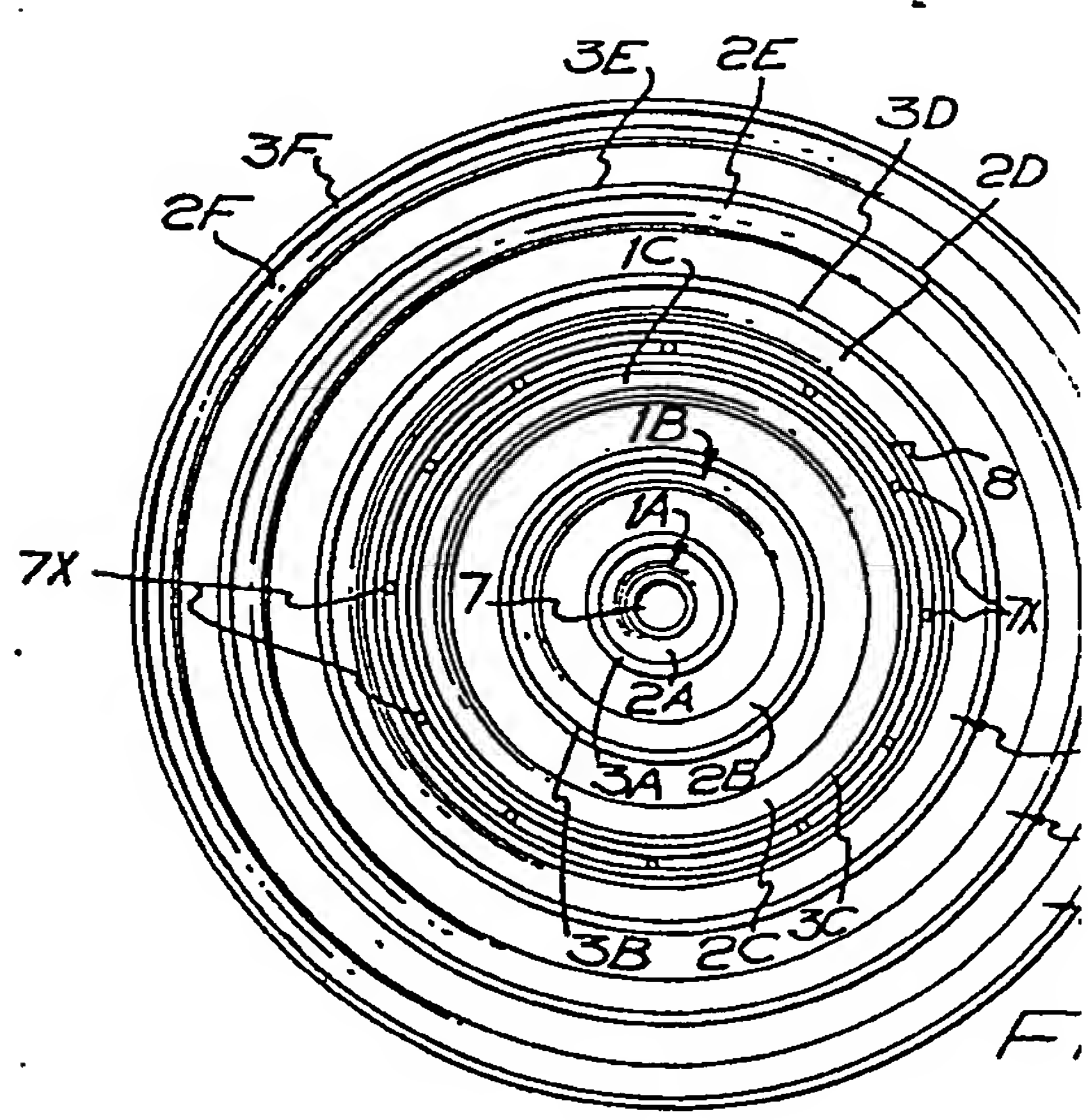
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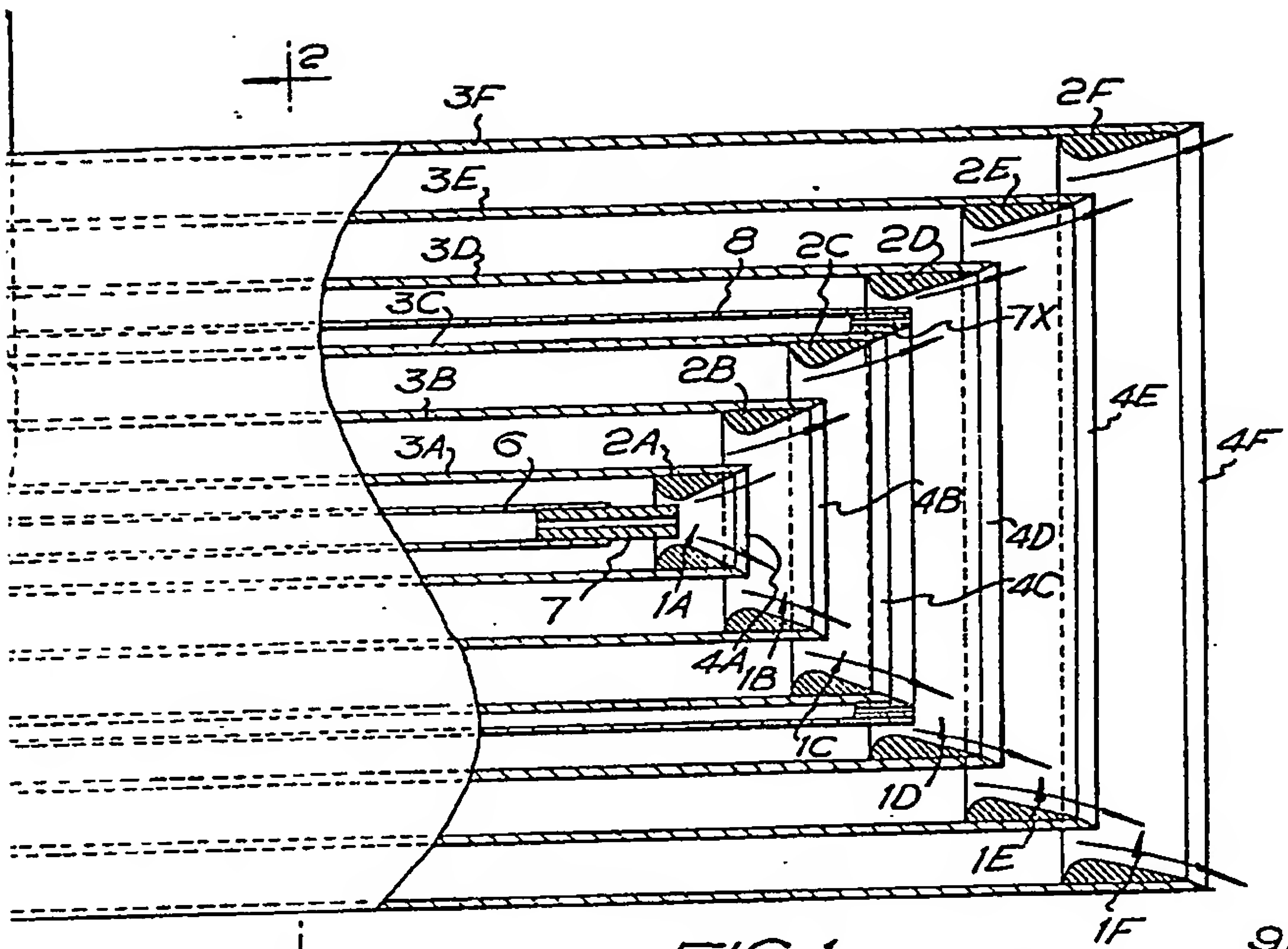


FIG. 1

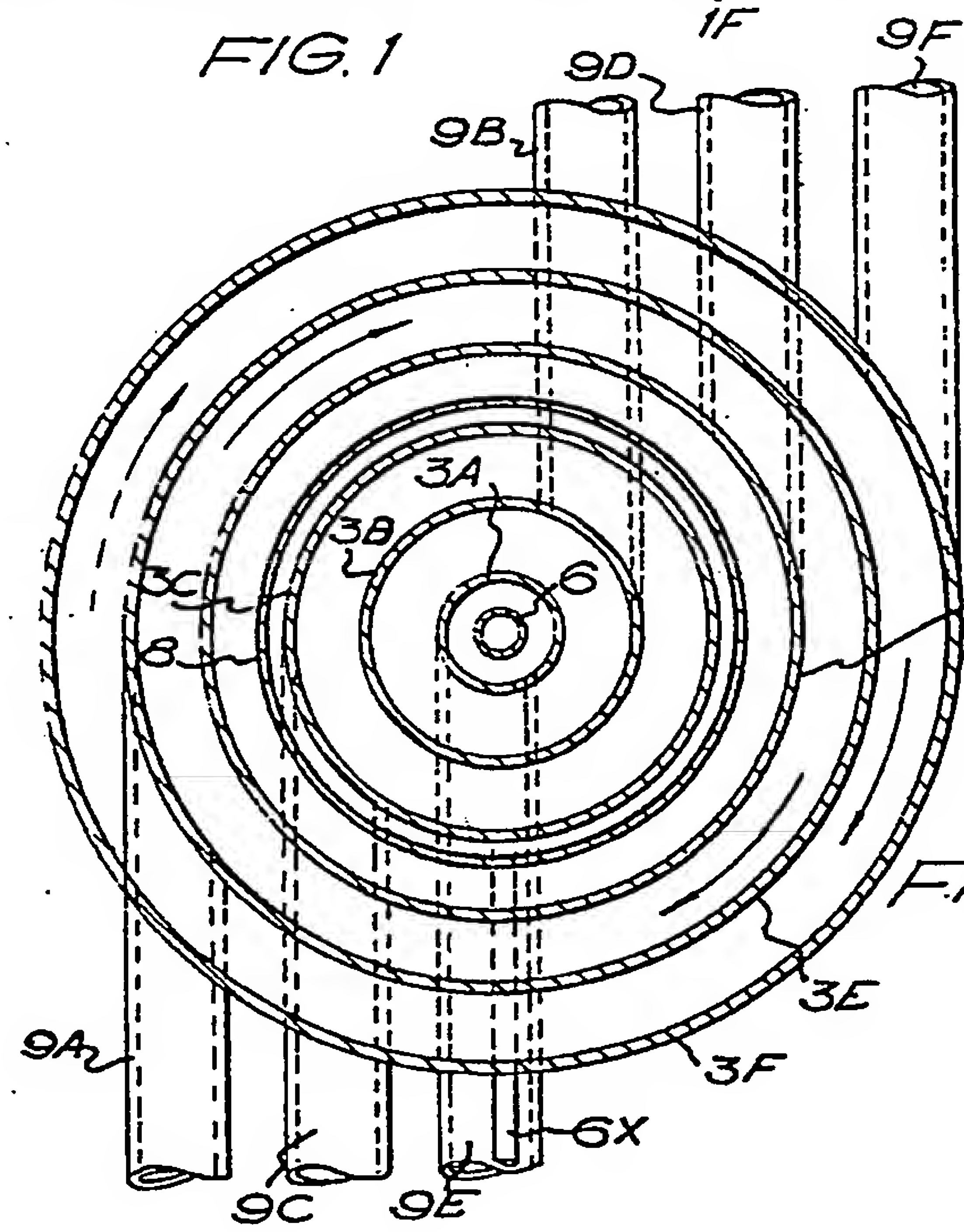
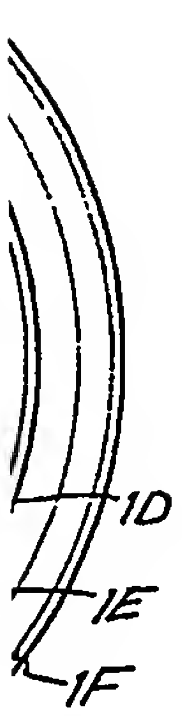


FIG. 2



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1099959 COMPLETE SPECIFICATION

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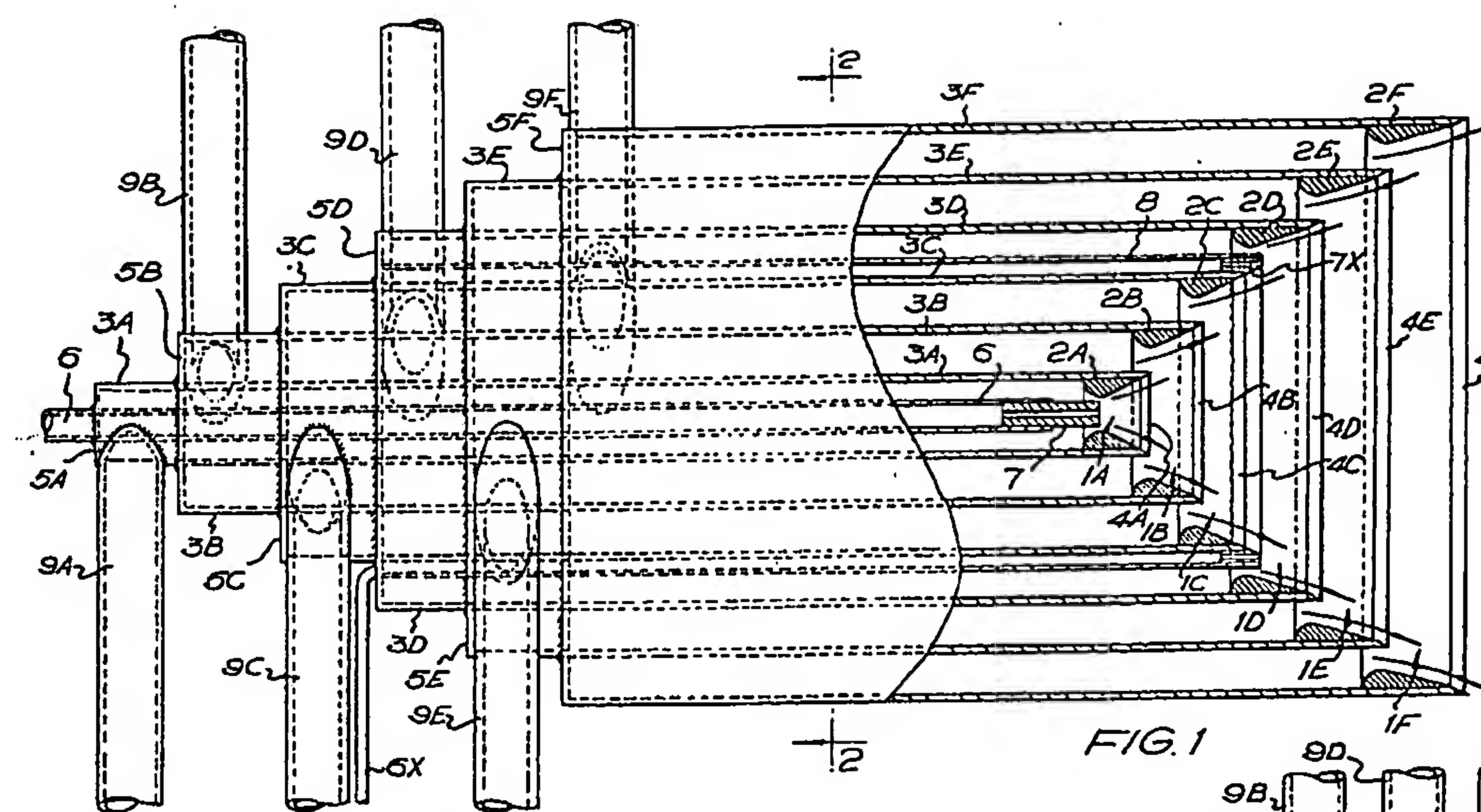

FIG. 1

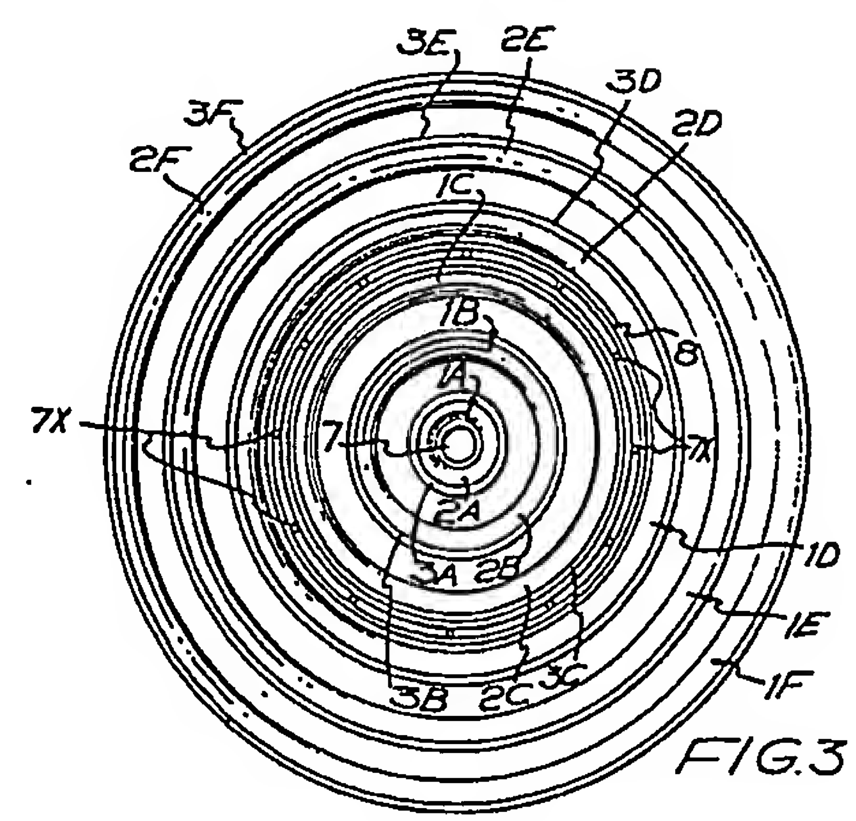

FIG. 3

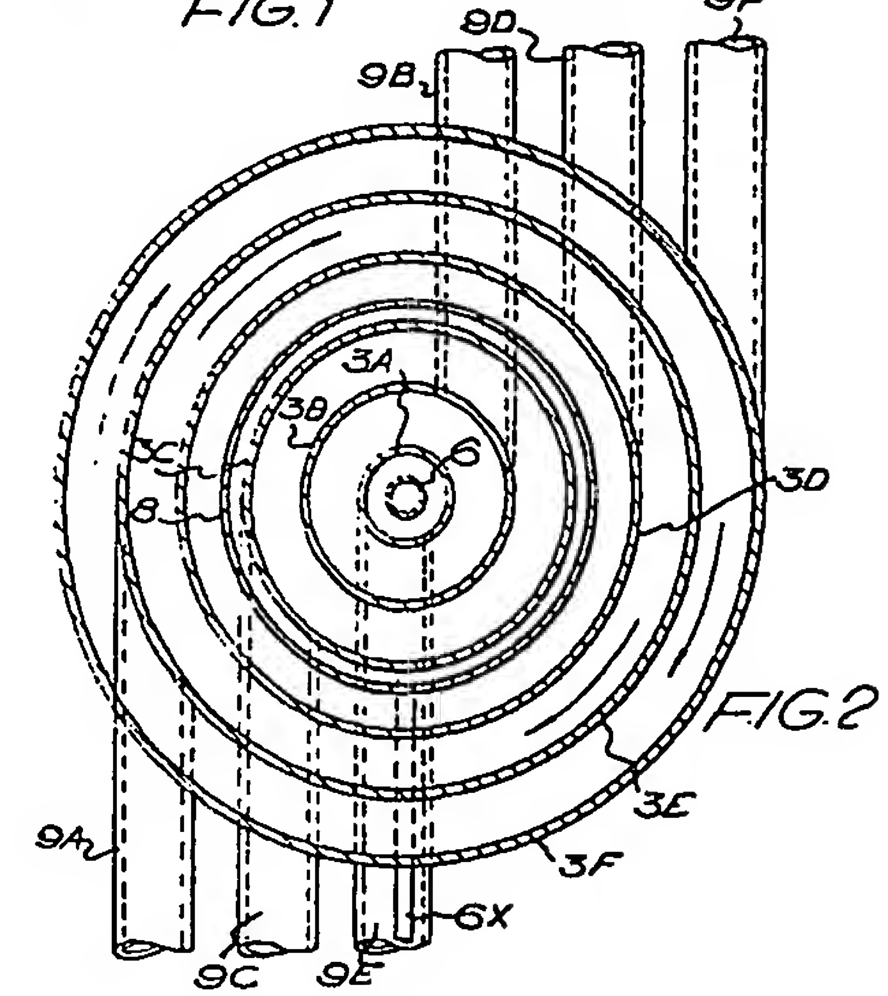

FIG. 2